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Image Compression and Resizing using Vector Quantization and Other Efficient Algorithms

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Abstract:
Image Compression is the method in which we reduce the total number of bits required to depict an image Vector Quantization is the mapping of pixel identity vectors into binary vectors showing a lesser number of possible reproductions and it is one of the major Image Compression algorithms. An image compression method will remove the irrelevant and duplicate information, and will encode the part which remains. Image compression is most important for efficient transmission and efficient storage of images. In this paper, we will be using Vector Quantization algorithm and K means algorithm for Image Compression. Firstly, we will compress the image using few of the underlying principles of VQ and then we will draw some conclusion out of it as a result of getting back the compressed image using parameters like distortion and reconstruction ratios.

Keywords: VQ, DWT, K-means, Lossy.

1. INTRODUCTION

Image Compression is one of the domains in Image Processing and most importantly Computer Science, where the demand has been increasing constantly. It is widely used in almost every sector. Image Processing and the encoder-decoder of VQ play an important role in the rise of demand of this field of study. We can get to see digital images [1-3]. Compression is done by removing the duplicate data such as Coding Redundancy and Inter pixel Redundancy [4]. Redundancy within pixels. There are generally two types of Image Compression methods namely, Lossy and Exact. We can get back the exact or original image in case of the exact technique. But, on the other hand, the lossy method allow us to be the victim of data loss but in a sort of a controlled manner. Exact image compression includes Huffman encoding, Area Coding and lossy image compression includes Vector Quantization, Block Truncation etc. Vector Quantization is one of the most powerful techniques which is used for image compression. Image vector quantization (VQ) includes four stages: vector formation, Training set selection, codebook generation and quantization. The first step is to divide the input image into set of vectors. The Subset of vectors in the set is later chosen as a training sequence. The codebook of codewords is obtained by an iterative clustering algorithm. Finally, in quantizing an input vector, closest codewords in the codebook is determined and corresponding label of this code word is transmitted. In this process, data compression is achieved because address transmission requires fewer bits than transmitting vector itself. The concept of data quantization is extended from scalar to vector data of arbitrary dimension. Instead of output levels, vector quantization employs a set of representation vectors (for one dimensional case) or matrices (for two dimensional cases). Set is defined as “codebook” and entries as “codewords”. Vector quantization has been found to be an efficient coding technique due to its inherent ability to exploit the high correlation between the neighboring pixels[3].

The quality of representation requires declaration of a distortion measure. There are already several algorithms [7–11] published on how to generate a codebook. The most commonly used VQ algorithm is the one presented by Linde, Buzo, and Gray, (LBG) [12] and generalized by Lloyd [13], 1982. The vector quantization puts the input samples into groups of well-defined vectors based on the distortion measure. The vector quantization has been widely used, beside the encoding/compression, in applications such as pattern recognition, speech recognition, face detection and neural networks design [14–16].

2. ALGORITHMS

2.1 LBG Algorithm

Generalized Lloyd Algorithm(GLA) or Linde-Buzo-Gray (LBG)Algorithm are the same thing. They used a mapping function to partition training vectors into N different collective groups.

The mapping function is defined as:

$R^k \rightarrow CB$

Let $X = (x_1, x_2 ... x_k)$ be a training vector and d(X; Y) be the Euclidean Distance between any two vectors. The iteration of GLA for a codebook generation is given as follows:

Step 1: Randomly generate an initial codebook CB 0.
Step 2: i = 0.
Step 3: Perform the following process for each training vector. Compute the Euclidean distances between the training vector and the codewords in CB i .

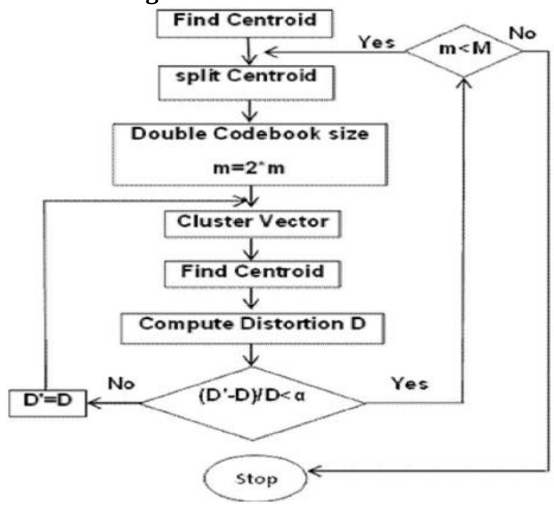
The Euclidean distance is
defined as

d(X; C) = (√∑ kt=1 (x t − c t) 2)........ (1)

Search the nearest codeword among CB i .
Step 4:Partition the codebook into N cells.
Step 5: Compute the centroid of each cell to obtain the new codebook CB i+1 .
Step 6: Compute the average distortion for CB i+1.

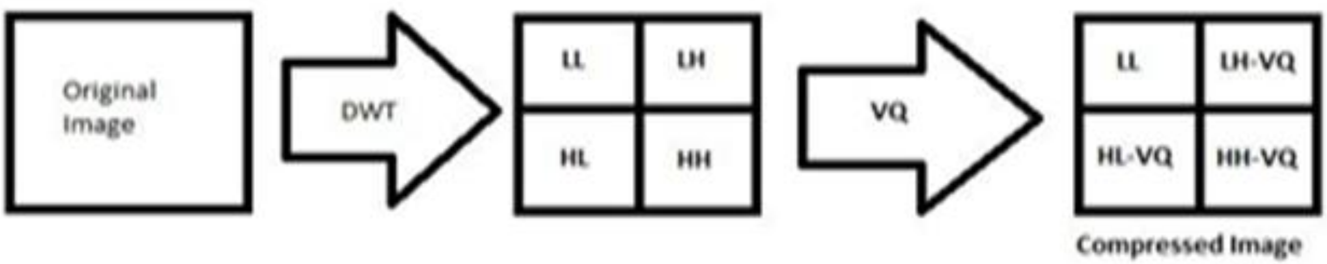
If it is changed by a small enough amount since the last iteration, the codebook may converge and the procedure stops. Otherwise, i = i + 1 and go to Step 3.

The Process goes like this.



There is a problem in being locally optimal and the utility is low as well [5].

2.2 DWT Algorithm



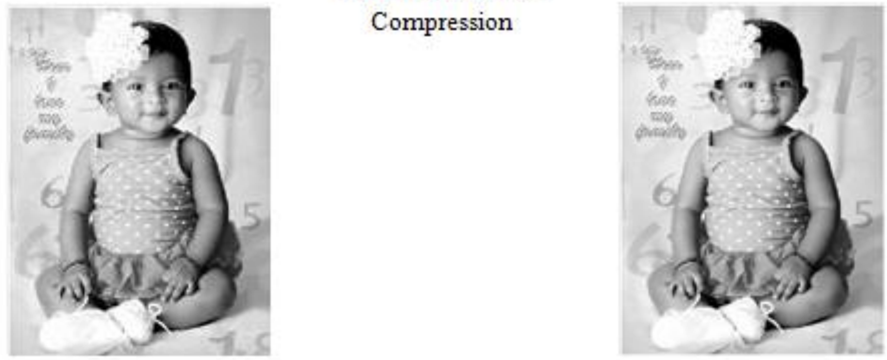
DWT is one of the widely used algorithms in the image processing and for image compression. Wavelets are often used to denoise two dimensional signals, such as images. The following example provides three steps to remove unwanted white Gaussian noise from the noisy image shown. Matlab was used to import and filter the image. The first step is to choose a wavelet type, and a level N of decomposition. In this case biorthogonal 3.5 wavelets were chosen with a level N of 10. Biorthogonal wavelets are commonly used in image processing to detect and filter white Gaussian noise, due to their high contrast of neighboring pixel intensity values. Using this wavelets a wavelet transformation is performed on the two dimensional image. Following the decomposition of the image file, the next step is to determine threshold values for each level from 1 to N. Birgé- Massart strategy[13] is a fairly common method for selecting these thresholds. Using this process individual thresholds are made for N = 10 levels. Applying these thresholds are the majority of the actual filtering of the signal. The final step is to reconstruct the image from the modified levels. This is accomplished using an inverse wavelet transform. The resulting image, with white Gaussian noise removed is shown below the original image. When filtering any form of data it is important to quantify the signal-to-noise-ratio of the result[14]. In this case, the SNR of the noisy image in comparison to the original was 30.4958%, and the SNR of the denoised image is 32.5525%. The resulting improvement of the wavelet filtering is a SNR gain of 2.0567%[15]. It is important to note that choosing other wavelets, levels, and thresholding strategies can result in different types of filtering. In this example, white Gaussian noise was chosen to be removed. Although, with different thresholding, it could just have easily been amplified.

3. PROPOSED METHOD

In my implementation for designing m size codebook of 4x4 vectors I have use simple algorithm whose steps are described below.
1. A*B size Image is partition into 4x4 blocks. These blocks are arranged into a vector this vector is called training set.
2. Initially, in a codebook, we take two vector one of contains whole zeros and one contains 255
3. Now find the mean of training set and we get one 16 elements vector. This vector is added into codebook.
4. Now training set is divided into two training set. By using Euclidian distance from initial vector. Here is vector which contains all zeros elements.
5. Now for this two training set again find mean of its. And we find two vectors. These two vectors are added into codebook.
6. Now this two training set are split into four training set. And this finding mean and splitting process done until we find m vector.

4. SIMULATION & RESULTS

DWT-VQ for Image Compression



Original image | Compressed Image

Image name	MSE	Total (MSE of original image with Zero Image)
Baby	7.9253e+006	1.8195e+009

The quality of reconstructed image depends upon the size of code book. If the codebook size is increased, we see (Table II) that the compression ratio (which is the ratio of the uncompressed size to the compressed size) decreases because the number of bits that represent the block is increased and MSE decrease.

Figure.1. The transition from Original size to 2 bits.

Codebook Size	2	4	8	16	32	64	128
MSP	8.0905e+006	8.0463e+006	8.0154e+006	7.9037e+006	7.5547e+006	6.8134e+006	6.4569e+006
Compression Ratio	6.1176	5.2000	4.5217	4	3.5862	3.2500	2.97

MSE and compression ratio of compressed image is shown table IV. Compression ratio is quite good if we consider the benefits of no losing information this what we exactly want to do “Compression without loss of information”.

5. CONCLUSION

Today is the most famous technique for compression is JPEG. JPEG achieve compression ratio from 2.4 up to 144. If we want high quality then JPEG provides 2.4 compression ratio and if we can compromises with quality then it will provide 144.our proposed system provides 2.97 to 6.11 compression ratio with high quality in sense of information loss. Though if we consider time as cost then our proposed system required more time because counting differential matrix is time consuming, but this defect can be removed if we provide efficient hardware component for our proposed system. We look forward to improve our work in the best way possible.

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